

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

**EP 0 943 653 A1**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
22.09.1999 Bulletin 1999/38

(51) Int. Cl.<sup>6</sup>: **C08K 5/521**, **C08K 5/527**,  
**C08L 69/00**

(21) Application number: **99104887.7**

(22) Date of filing: **11.03.1999**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

(30) Priority: **16.03.1998 JP 6503198**

(71) Applicant:  
**DAICEL CHEMICAL INDUSTRIES, LTD.**  
**Sakai-shi, Osaka (JP)**

(72) Inventor: **Katayama, Masahiro**  
**Sakai-shi, Osaka (JP)**

(74) Representative:  
**Grünecker, Kinkeldey,**  
**Stockmair & Schwanhäusser**  
**Anwaltssozietät**  
**Maximilianstrasse 58**  
**80538 München (DE)**

(54) **Polycarbonate-based flame retardant resin composition**

(57) The object is to provide a polycarbonate flame retardant resin composition which has high heat resistance and impact resistance, and excellent flame retardation, and generates neither corrosive nor poisonous gas at the time of burning. The present invention provides a polycarbonate flame retardant resin composition which comprises an aromatic polycarbonate (A), a styrene-based resin (B), a phosphoric ester compound (C), an organic phosphorus compound (D), and optionally a fluorocarbon resin (E) or a polyphenylene ether-based resin (F), a ratio of phosphorus concentration of the organic phosphorus compound (D) to that of the ester compound (C),  $P_D/P_C$ , being less than 2, which does not include 0 substantially, in the resin composition.

## Description

## Field of the Invention

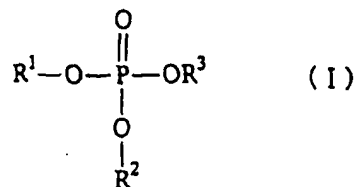
- 5 [0001] The present invention relates to a polycarbonate-based flame retardant resin composition which is excellent in heat resistance and impact resistance and which has high flame retardation.

## Prior art

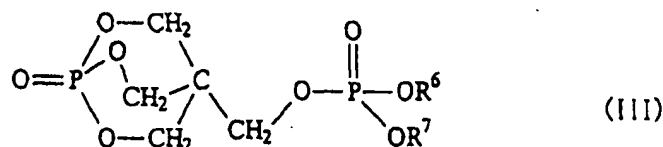
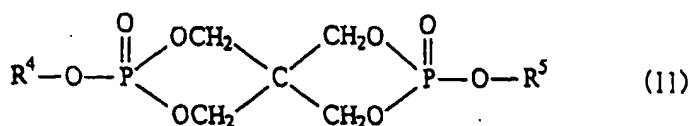
- 10 [0002] Blends of a polycarbonate resin and a styrene-based resin represented by an ABS resin have high heat resistance and impact resistance. Therefore, they have widely been used as so-called polymer alloys as various molded products such as car parts, and electric and electronic parts. In the case in which the polymer alloys are used in electric and electronic parts, or a housing, an enclosure, a chassis or the like of office automation (OA) apparatus, flame retardation is demanded.
- 15 [0003] Particularly in recent years, for molded products of OA apparatus or electric goods for home use authorization of standards V-0 and 5V has been frequently demanded, which are flame retardant levels based on subject 94 by UL (Under lighters laboratory), which is a flame retardation standard in USA, in order to raise the safety of the goods.
- [0004] On the other hand, in order to reduce the used amount of raw materials, it is useful to make parts and housings compact and make their thickness thin. At the time of burning, however, there arises drip of a melted resin from a thin
- 20 portion of the molded product, resulting in a risk of the spread of the fire to other combustibles. In flame retardant resin compositions, therefore, a high flame retardation, which does not cause drip, is also demanded.
- [0005] In order to give flame retardation, a halogen compound is usually added to a polymer alloy of polycarbonate and a styrene-based resin. However, a halogen compound has a drawback that corrosive or poisonous gas is generated at the time of processing or burning. Thus, it has been desired to develop a non-halogen flame retardant that
- 25 hardly causes such problems.
- [0006] As the non-halogen flame retardant, organic phosphorus compounds are used. As a typical organic phosphorus compound, triphenyl phosphate is well known. Triphenyl phosphate, however, has a disadvantage that heat resistance is poor and volatility is high.
- [0007] As an organic phosphorus compound having a low volatility, US Patent No. 5,204,394 and 5,122,556 describe
- 30 condensed phosphoric esters. These are more excellent in heat resistance than triphenyl phosphate. However, the resistance is not sufficient from the viewpoint of balance with flame retardation. Many of these condensed phosphoric esters are liquid compounds, and cause a drop in thermal deformation temperature of a resin compound and the like, to deteriorate physical properties of the resin.

## 35 Disclosure of the invention

- [0008] Therefore, an object of the present invention is to provide a polycarbonate-based flame retardant resin composition which has high heat resistance and impact resistance, and excellent flame retardation, and generates neither
- 40 corrosive nor poisonous gas at the time of burning.
- [0009] The inventor has eagerly made investigations to attain the above-mentioned object. As a result, the inventor has found that by using a phosphoric ester compound and a specified organic phosphorus compound together as a non-halogen flame retardant, it is possible to obtain a molded product having excellent heat resistance and impact resistance that cannot be obtained by using a single of them and having high flame retardation.
- [0010] That is, the present invention is a polycarbonate-based flame retardant resin composition which comprises an
- 45 aromatic polycarbonate (A), a styrene-based resin (B), a phosphoric ester compound (C) represented by the following formula (I) and an organic phosphorus compound (D) represented by the following formula (II) or (III), a ratio of a phosphorus concentration of the organic phosphorus compound (D) to that of the phosphoric ester compound (C),  $P_D/P_C$ , being less than 2, which does not include 0 substantially, in the composition:



wherein  $R^1$ ,  $R^2$  and  $R^3$  are the same as or different from one another and are a phenyl group which may have an alkyl group having 1 to 4 carbon atoms;



wherein  $R^4$  and  $R^5$  are aryl groups which may have 1 to 3 alkyl groups having 1 to 4 carbon atoms,  $R^4$  and  $R^5$  may be the same or different,  $R^6$  and  $R^7$  each represents a straight chain or branched alkyl group having 1 to 10 carbon atoms, a phenyl group, or an alkyl phenyl group which has 1 to 3 alkyl groups having 1 to 5 carbon atoms.

#### Advantageous effect

[0011] The combination of specified phosphorus compounds makes it possible to obtain a polycarbonate flame retardant resin composition which generates neither corrosive nor poisonous gas at the time of processing or burning, has excellent flame retardation, exhibits a small decrease in physical properties such as heat resistance and impact resistance, and contains no halogen.

#### Embodiments of the invention

[0012] The aromatic polycarbonate that is the component (A) of the present invention includes ones obtained by reaction of various dihydroxyaryl compounds and phosgene, or ones obtained by ester interchange reaction of dihydroxyaryl compounds and diphenylcarbonate. A typical polycarbonate is one obtained by reaction of 2,2'-bis(4-hydroxyphenyl)propane and phosgene.

[0013] The dihydroxyaryl compounds which are raw materials of polycarbonate may be bis(4-hydroxyphenyl)methane, 1,1'-bis(4-hydroxyphenyl)ethane, 2,2'-bis(4-hydroxyphenyl)propane, 2,2'-bis(4-hydroxyphenyl)butane, 2,2'-bis(4-hydroxyphenyl)octane, 2,2'-bis(4-hydroxy-3-methylphenyl)propane, 2,2'-bis(4-hydroxy-3-*t*-butylphenyl)propane, 2,2'-bis(3,5-dimethyl-4-hydroxyphenyl)propane, 2,2'-bis(4-hydroxy-3-cyclohexylphenyl)propane, 2,2'-bis(4-hydroxy-3-methoxyphenyl)propane, 1,1'-bis(4-hydroxyphenyl)cyclopentane, 1,1'-bis(4-hydroxyphenyl)cyclohexane, 1,1'-bis(4-hydroxyphenyl)cyclododecane, 4,4'-dihydroxyphenyl ether, 4,4'-dihydroxy-3,3'-dimethylphenyl ether, 4,4'-dihydroxydiphenyl sulfide, 4,4'-dihydroxy-3,3'-dimethyldiphenyl sulfide, 4,4'-dihydroxydiphenyl sulfoxide, 4,4'-dihydroxydiphenylsulfone, bis(4-hydroxyphenyl)ketone and the like. These dihydroxyaryl compounds may be used alone or in combination of two or more.

[0014] Preferred dihydroxyaryl compounds include bisphenols bis(hydroxyphenyl)alkane such as 2,2'-bis(4-hydroxyphenyl)propane, bis(hydroxyphenyl)cycloalkane such as bis(4-hydroxyphenyl)cyclohexane, dihydroxydiphenyl sulfide, dihydroxydiphenyl sulfone, dihydroxydiphenyl ketone and the like, which can form aromatic polycarbonates having a high heat resistance. Especially preferred dihydroxyaryl compounds include 2,2'-bis(4-hydroxyphenyl)propane, which can form bisphenol A type aromatic polycarbonate.

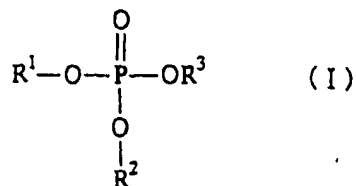
[0015] At the time of producing bisphenol A type aromatic polycarbonate, a part of bisphenol A may be replaced by other dihydroxyaryl compound if the replacement is conducted within the scope that heat resistance, mechanical strength and the like are not damaged.

[0016] The styrene-based resin that is the component (B) of the present invention may be a homopolymer or a copol-

ymers of styrene or a styrene derivative such as  $\alpha$ -methylstyrene or vinyl toluene, a copolymer of such a monomer and a vinyl monomer such as acrylonitrile or methylmethacrylate, a resin resulting from graft polymerization of styrene and/or a styrene derivative, or styrene and/or a styrene derivative and other vinyl monomer to diene-based rubber such as polybutane, ethylene/propylene-based rubber, acrylic rubber or the like. For example, the resin may be polystyrene, high impact polystyrene, AS resin, MAS resin, ABS resin, AAS resin, AES resin, MBS resin, or the like.

[0017] When the aromatic polycarbonate (A) and the styrene-based resin (B) are melted and mixed, a so-called polymer alloy can be formed to obtain a molded product having high heat resistance and impact resistance. The ratio of the aromatic polycarbonate to the styrene-based resin can be selected from the range that heat resistance, impact resistance and melt fluidity, and the like are not damaged. For example, the ratio is the following degree: (A)/(B) = 40 to 95 / 60 to 5 (% by weight), and preferably 50 to 95 / 50 to 5 (% by weight), and more preferably 55 to 85 / 45 to 15 (% by weight). If the aromatic polycarbonate content is less than 40 % by weight, melt fluidity is high but heat resistance and impact resistance of the molded product are liable to be lowered. If it is more than 95 % by weight, melt fluidity is liable to be lowered in molding process.

[0018] The characteristic of the present invention is that, by using a phosphoric ester compound that is the component (C) and an organic phosphorus compound that is the component (D) together, it is possible to obtain a resin-molded product having excellent mechanical properties and high flame retardation that cannot be obtained by using a single of them. The phosphoric ester compound (C) is represented by the following formula (I):

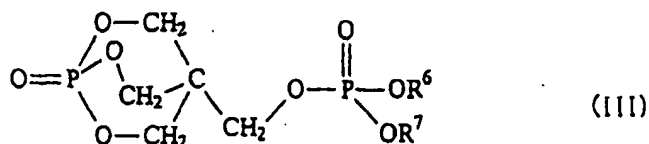
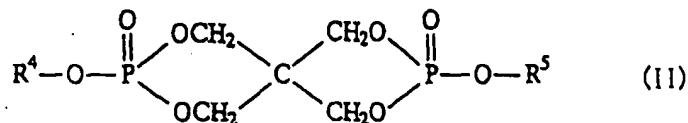


wherein  $\text{R}^1$ ,  $\text{R}^2$  and  $\text{R}^3$  are phenyl groups which may have an alkyl group having 1 - 4 carbon atoms, and  $\text{R}^1$ ,  $\text{R}^2$  and  $\text{R}^3$  may be the same or different.)

[0019] The phosphoric ester compound that is the component (C) includes trimethyl phosphate, triethyl phosphate, tributyl phosphate, tri(2-ethylhexyl) phosphate, tributoxyethyl phosphate, trioleyl phosphate, triphenyl phosphate, tricresyl phosphate, trixylenyl phosphate, tris(isopropylphenyl) phosphate, tris(o-phenylphenyl) phosphate, tris(p-phenylphenyl) phosphate, trinaphthyl phosphate, cresyldiphenyl phosphate, xylenyldiphenyl phosphate, diphenyl(2-ethylhexyl) phosphate, di(isopropylphenyl)phenyl phosphate, o-phenylphenyldicresyl phosphate, dibutyl phosphate, monobutyl phosphate, di-2-ethylhexyl phosphate, monoisodecyl phosphate, 2-acryloyloxyethyl acid phosphate, 2-methacryloyloxyethyl acid phosphate, diphenyl-2-acryloyloxyethyl phosphate, diphenyl-2-methacryloyloxyethyl phosphate, condensed products thereof, and the like. These phosphoric esters may be used alone or in combination of two or more.

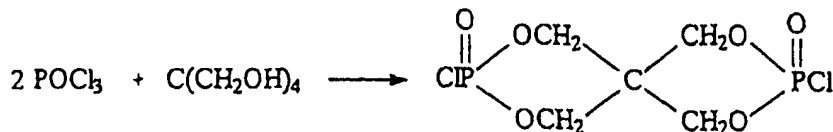
[0020] It is preferred to use, among these phosphoric ester compounds, compounds represented by the formula (I) wherein  $\text{R}^1$ ,  $\text{R}^2$  and  $\text{R}^3$  each independently represents an aromatic group selected from phenyl, o-cresyl, p-cresyl and m-cresyl groups. Such phosphoric ester compounds include triphenyl phosphate, tricresyl phosphate, cresyldiphenyl phosphate and the like. Of these, triphenyl phosphate is especially preferably used.

[0021] The organic phosphorus compound (D) in the present invention is represented by the following formula (II) or formula (III):

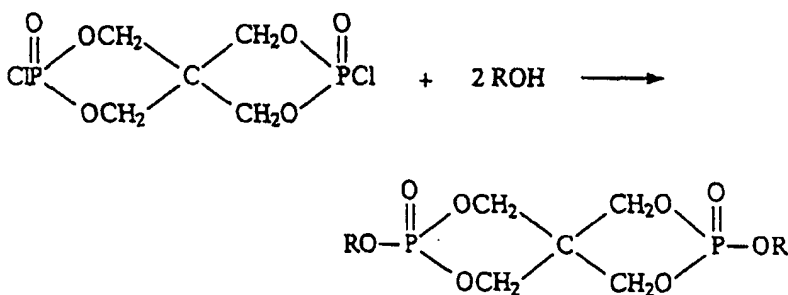


wherein  $\text{R}^4$  and  $\text{R}^5$  are aryl groups which may have 1 to 3 alkyl groups having 1 to 4 carbon atoms,  $\text{R}^4$  and  $\text{R}^5$  may be the same or different;  $\text{R}^6$  and  $\text{R}^7$  each represents a straight chain or branched alkyl group having 1 to 10 carbon atoms, a phenyl group, or an alkylphenyl group which has 1 to 3 alkyl groups having 1 to 5 carbon atoms.

[0022] The organic phosphorus compound (D) can be produced by a known method. For example, according to US Patent No. 3,090,799, the compound of the formula (II) can be produced by reacting pentaerythritol with phosphorus oxychloride, as is illustrated by the following scheme:



and then reacting the above-mentioned intermediate product with a monovalent phenol as is illustrated in the following scheme:



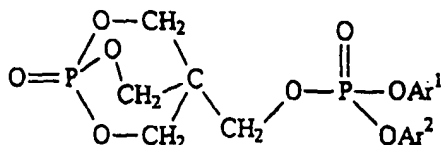
wherein R's are aromatic groups corresponding to  $\text{R}^4$  and  $\text{R}^5$ .

[0023] In the present invention,  $\text{R}^4$  and  $\text{R}^5$  are aryl groups which may have 1 to 3 alkyl groups having 1 to 4 carbon atoms, and are, for example, phenyl, 2-methylphenyl, 4-methylphenyl, 2,6-dimethylphenyl, 2,4,6-trimethylphenyl, 2,6-di-tert-butylphenyl, 2,4,6-tri-tert-butylphenyl or the like.

[0024] In the organic phosphorus compound represented by the formula (III),  $\text{R}^6$  and  $\text{R}^7$  each independently represents methyl, ethyl, isobutyl, t-butyl, n-butyl, neopentyl, cyclohexyl, n-hexyl, n-octyl, n-nonyl, phenyl, 2-methylphenyl, 4-methylphenyl, 2-ethylphenyl, 4-ethylphenyl, 2-isopropylphenyl, 4-isopropylphenyl, 2-n-butylphenyl, 4-n-butylphenyl, 2-

isobutylphenyl, 4-isobutylphenyl, 2-t-butylphenyl, 4-t-butylphenyl, 2-neopentylphenyl, 4-neopentylphenyl, 2,4-dimethylphenyl, 2,6-dimethylphenyl, 2,4-di-t-butylphenyl, 2,6-di-t-butylphenyl, 4-t-butyl-2-methylphenyl, 2-t-butyl-4-methylphenyl, 2,4,6-trimethylphenyl, 2,4,6-tri-t-butylphenyl, 2,4-di-t-butyl-6-methylphenyl, 2,6-di-t-butyl-4-methylphenyl, 4-t-butyl-2,6-dimethylphenyl, 2-t-butyl-4,6-dimethylphenyl or the like. These may be used along or in combination of two or more.

[0025] Preferred compounds among the organic phosphorus compounds represented by the formula (III) are ones represented by the following formula:



wherein Ar<sup>1</sup> and Ar<sup>2</sup> are phenyl groups, or phenyl groups which have 1 to 3 alkyl groups having 1 to 5 carbon atoms.

[0026] In the above-mentioned formula, both of Ar<sup>1</sup> and Ar<sup>2</sup> are preferably phenyl, 2-methylphenyl, 2-ethylphenyl, 2-isopropylphenyl, 2-t-butylphenyl, 4-t-butylphenyl, 2,4-dimethylphenyl, 2,6-dimethylphenyl, 2,4-di-t-butylphenyl, 2,6-di-t-butylphenyl, 4-t-butyl-2-methylphenyl, 2-t-butyl-4-methylphenyl, 2,4,6-trimethylphenyl, 2,4,6-tri-t-butylphenyl, 2,4-di-t-butyl-6-methylphenyl, or 2,6-di-t-butyl-4-methylphenyl. Both of them are more preferably phenyl, among these.

[0027] The organic phosphorus compound represented by the formula (III) is produced, for example, by reacting 4-hydroxymethyl-1-oxo-2,6,7-trioxa-1-phosphabicyclo[2.2.2]octane with a suitable chlorophosphate derivative in amounts of equivalent moles, in the presence of a base such as pyridine, in a suitable solvent such as dichloromethane.

[0028] In the resin composition of the present invention, the blend amount of the phosphoric ester compound (C) is 5 - 50 parts by weight per 100 parts by weight of a thermoplastic resin mixture comprising the aromatic polycarbonate (A) and the styrene-based resin (B). If the blend amount is less than 5 parts by weight, flame retardant effect is not sufficient. If it is more than 50 parts by weight, electric properties are also lowered, which is not preferable.

[0029] The blend amount of the organic phosphorus compound (D) is 0.5 - 30 parts by weight per 100 parts by weight of the thermoplastic resin mixture comprising the aromatic polycarbonate (A) and the styrene-based resin (B). If the blend amount is less than 0.5 parts by weight, synergetic effect for improvement in flame retardation, which is based on use together with the phosphoric ester compound (C), cannot be obtained. If it is more than 30 parts by weight, mechanical properties such as impact resistance are remarkably lowered, which is not preferable.

[0030] In the present invention, concerning the blend ratio of the phosphoric ester compound (C) to the organic phosphorus compound (D), the phosphorus concentration ratio (P<sub>D</sub>/P<sub>C</sub>) of the organic phosphorus compound (D) to the phosphoric ester compound (C) in the resin composition is less than 2 (which does not include 0 substantially), preferably 0.1 to 1.9, far preferably 0.5 to 1.0. If the phosphorus concentration ratio (P<sub>D</sub>/P<sub>C</sub>) is more than 2, synergetic effect for improvement in flame retardation by using the phosphoric ester compound (C) and the organic phosphorus compound (D) together is lowered.

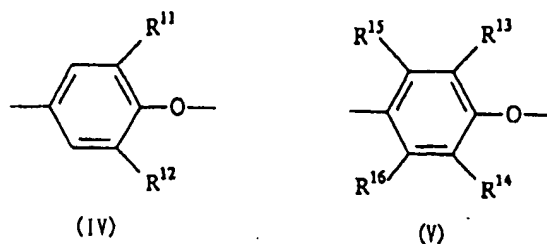
[0031] The fluorocarbon resin that is the component (E) of the present invention functions as a flame retardant aid for suppressing a live charcoal and drip of melted liquid. The fluorocarbon resin includes, for example, homopolymers or copolymers of a fluorine-containing monomer such as tetrafluoroethylene, chlorotrifluoroethylene, vinyl fluoride, vinylidene fluoride, hexafluoropropylene, or perfluoroalkylvinyl ether, and copolymers of the above-mentioned fluorine-containing monomer and a polymerizable monomer such as ethylene, propylene or acrylate. Typical examples of the fluorocarbon resin are homopolymers such as polytetrafluoroethylene, polychlorotrifluoroethylene, and polyvinylidene fluoride, tetrafluoroethylenehexafluoropropylene copolymer, tetrafluoroethyleneperfluoroalkylvinyl ether copolymer, tetrafluoroethylenehexafluoropropylene-perfluoroalkylvinyl ether copolymer, ethylene-tetrafluoroethylene copolymer, ethylenechlorotrifluoroethylene copolymer and the like. These fluorocarbon resins may be used alone or in combination of two or more. Among these fluorocarbon resins, polytetrafluoroethylene is preferred. The fluorocarbon resins can be obtained by a conventional process, for example, an emulsion polymerization process described in US Patent No. 2,393,967.

[0032] The fluorocarbon resin may be blended by melt-mixing with the aromatic polycarbonate and the styrene-based resin. In many cases, however, it is used as powder having an average particle size of 10 to 5000 μm, preferably 100 to 1000 μm, and more preferably 200 to 700 μm. This size means an average size of fluorocarbon resin of particles, which may have coagulate in the composition, existing in the composition.

[0033] For example, the used amount of the fluorocarbon resin (E) is 0.05 to 5 parts by weight, preferably 0.1 to 2 parts by weight and more preferably 0.2 to 1 parts by weight per 100 parts by weight of the thermoplastic resin mixture comprising the aromatic polycarbonate (A) and the styrene-based resin (B). If the added amount of the fluorocarbon

resin is less than 0.05 parts by weight, the effect of preventing drip is small so that it is difficult to give a high flame retardation to the molded product. If it is more than 5 parts by weight, thermal shrinkage of the molded product is large so that dimensional precision at the time of heating is lowered and costs also become high.

[0034] The polyphenylene ether-based resin (F) used in the present invention is a homopolymer or a copolymer having monomer units represented by the following formula (IV) or (V). These polyphenylene ether-based resins may be used along or in combination of two or more;



wherein  $R^{11}$ ,  $R^{12}$ ,  $R^{13}$ ,  $R^{14}$ ,  $R^{15}$  and  $R^{16}$  each independently represents an alkyl group having 1 to 4 carbon atoms (methyl, ethyl, propyl, butyl, t-butyl group and the like), an aryl group (phenyl group and the like), or a hydrogen atom, provided that both of  $R^{15}$  and  $R^{16}$  are not hydrogen atoms at the same time.

[0035] The polyphenylene ether-based homopolymer includes poly(2,6-dimethyl-1,4-phenylene) ether, poly(2-methyl-6-ethyl-1,4-phenylene) ether, poly(2,6-diethyl-1,4-phenylene) ether, poly(2-ethyl-6-n-propyl-1,4-phenylene) ether, poly(2,6-di-n-propyl-1,4-phenylene) ether, poly(2-methyl-6-n-butyl-1,4-phenylene) ether, poly(2-ethyl-6-isopropyl-1,4-phenylene) ether, poly(2-methyl-6-hydroxyethyl-1,4-phenylene) ether and the like. Of these, poly(2,6-dimethyl-1,4-phenylene) ether is preferred.

[0036] The polyphenylene ether-based copolymer is a copolymer having a phenylene ether structure as a main monomer unit, and includes copolymers of a monomer that forms the above-mentioned homopolymer (in particular, 2,6-dimethylphenol or the like) and another phenols, (for example, a copolymer of 2,6-dimethylphenol and 2,3,6-trimethylphenol, a copolymer of 2,6-dimethylphenol and o-cresol, a copolymer of 2,6-dimethylphenol, 2,3,6-trimethylphenol and o-cresol).

[0037] For example, the used amount of the polyphenylene ether-based resin (F) is 0.1 to 20 parts by weight, preferably 0.1 to 10 parts by weight and more preferably 0.5 to 5 parts by weight per 100 parts by weight of the thermoplastic resin mixture comprising the aromatic polycarbonate (A) and the styrene-based resin (B). If the used amount of the polyphenylene ether-based resin is less than 0.1 parts by weight, the effect of giving flame retardation is small. If it is more than 20 parts by weight, the strength of the molded product is lowered.

[0038] In the flame retardant resin composition of the present invention, the following and variable additives may be added: for example, antidegradants such as an oxidation inhibitor, an ultraviolet ray absorbent and a light resistance agent, a lubricant, an antistatic agent, a releasing agent, a plastitizer, reinforcing fibers such as glass fiber, carbon fiber, polyamide fiber, or polyester fiber, a filler such as calcium carbonate or talc, a colorant such as a pigment. The used amount of the additive may be suitably selected dependently on the sort of the additive, within the scope that heat resistance, impact resistance, mechanical strength and the like are not damaged.

#### Preparation of a flame retardant resin composition

[0039] The flame retardant resin composition of the present invention may be a composition obtained by pre-mixing the aromatic polycarbonate (A), the styrene resin (B), the phosphoric ester compound (C), the organic phosphorus compound (D), and optionally the fluorocarbon resin (E), in a mixer such as a V-type blender, a supermixer, a super flouter, or a Henschel mixer. In many cases, however, the composition is usually a mixture obtained by melt-mixing the above-mentioned pre-mixture uniformly. Such a mixture can be obtained by melt-mixing the above-mentioned pre-mixture in a kneading means at, for example, 200 to 300 °C, preferably about 220 to 280 °C to form pellets. As the kneading means, various melting kneaders may be used, for example, a kneader, a monoaxial or biaxial extruder, or the like. In many case, however, the resin composition is melted and extruded in the biaxial extruder or the like, and then is made into pellets by a pelletizer.

[0040] The flame retardant resin composition of the present invention is useful as a raw material of a various molded products such as housings and enclosures of electric goods for home use and for OA apparatus, housings and casings of portable telephones, and the like. Such molded products can be produced by a conventional method, for example, by injection-molding a pellet form flame retardant resin composition at a cylinder temperature of about 220 to 280 °C in a injection molding machine.

**[0041]** The following will explain the present invention in detail, but the scope of the present invention is not limited to these examples. Evaluation of resin compositions of the following Examples and Comparative Examples was performed by the following manners.

(1) Thermal deformation temperature

**[0042]** Thermal deformation temperature was measured according to ASTM D-256 by applying a load of 18.6 kg/cm<sup>2</sup> to a test piece of 1/4 inch thickness.

**(2) Izod impact strength**

**[0043]** Izod impact strength was measured according to ASTM D-256 by using a test piece having a cut notch and having a thickness of 1/4 inches.

### (3) Flame retardation

**[0044]** Flame retardation was evaluated according to vertical fire test (94V-0) prescribed in the UL standard of the US, UL-94, as evaluation criteria, by using a test piece of 1/16 inch thickness.

### Production example of a thermoplastic resin mixture

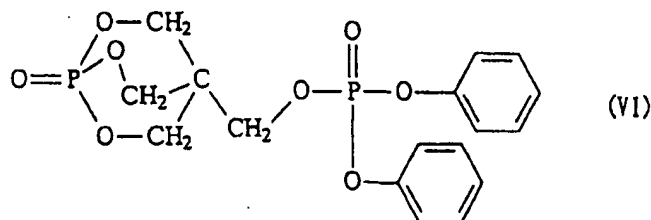
**[0045]** As a polycarbonate resin, Toughlon FN2200 (trade name, manufactured by Idemitsu Petrochemical Co., Ltd., bisphenol A type polycarbonate, viscosity average molecular weight 22,000)(A1) was used. As styrene resins, the following were used.

- ① A polymer (B1) obtained by polymerizing 75 % by weight of styrene and 25 % by weight of acrylonitril in an aqueous solution of a calcium phosphate type dispersant in a suspension polymerization manner.
- ② A polymer (B2) obtained by graft-polymerizing 45 parts by weight of styrene and 15 parts by weight of acrylonitril in the presence of polybutadiene rubber latex (40 parts by weight, which was a value converted into a dry basis) in an emulsion polymerization manner.
- ③ A polymer (B3) obtained by adding 0.015 parts by weight of di-*t*-butylperoxide (DTBPO) to 100 parts by weight of a mixture solution wherein 90 parts by weight of styrene and 10 parts by weight of polybutadiene rubber were dissolved and then polymerizing the solution in a bulk polymerization manner.

**[0046]** They were mixed at the following ratios, respectively: A1/B1/B2 = 80/13/7, and 70/20/10, and A1/B3 = 80/20 (weight ratio). Thus, resin mixtures were obtained (the respective resin mixtures were called AB-1, AB-2 and AB-3).

**Examples 1 to 8, and Comparative Examples 1 to 5**

[0047] The following were used: the above-mentioned thermoplastic resin compositions (AB-1, AB-2 and AB-3), triphenyl phosphate (TPP) as the phosphoric ester compound (C), diphenylpentaerythritol diphosphate (DPPDP) (m.p.: 197 °C) as the organic phosphorus compound (D), an organic phosphorus compound (BPPE) represented by the following formula (VI) (m.p.: 165 °C):



polytetrafluoroethylene (manufactured by Daikin Industries, Ltd., trade name: Polyflon TFE, average particle diameter:

about 500  $\mu\text{m}$ ), as a fluorocarbon resin (E), poly(2,6-dimethyl-1,4-phenylene) ether (PPE) [GE Specialty Chemicals, Inc., BLENDEX HPP 820] as the polyphenylene ether-based resin (F) were used. These were added at ratios (by weight) shown in Tables 1 and 2, and then pre-mixed in a V-type blender for 40 minutes. This pre-mixed product was melt-extruded by a biaxial kneading extruder to make pellets.

[0048] The resultant pellets were dried for not less than 4 hours in an oven at 80 °C, and subsequently were subjected to an injection molding machine (cylinder temperature: 250 °C, mold temperature: 60 °C) to prepare test pieces for ordinary physical properties. Physical properties were then measured by ordinary methods. The results are shown Tables 1 and 2.

Table 1

	EXAMPLES							
	1	2	2	4	5	6	7	8
PC/ABS(AB-1)	100	100	100	100	100			
PC/ABS(AB-2)						100		
PC/HIPS(AB-3)							100	100
TPP(C)	6.3	6.3	4.7	3.5	3.5	6.3	5.3	3.7
DPPDP(D)	2	2	3	3.8		4	3.3	3.9
BPPE(D)					3.8			
FLUOROCARBON RESIN(E)		0.3	0.3	0.3	0.3	0.3	0.3	0.3
PPE(F)								3
PHOSPHORUS CONCENTRATION RATIO ( $P_D/P_C$ )	0.5	0.5	1	1.7	1.7	1	1	1.7
THERMAL DEFORMATION TEMPERATURE(°C)	90	90	93	95	94	87	84	86
IZOD IMPACT STRENGTH (kg · cm/cm)	17	17	15	13	15	10	10	8
FLAME RETARDATION (UL94)	V-2	V-0	V-0	V-0	V-0	V-0	V-0	V-0

Table 2

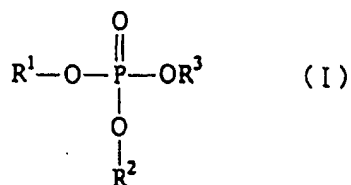
	COMPARATIVE Examples				
	1	2	3	4	5
PC/ABS(AB-1)	100	100	100	100	100
PC/ABS(AB-2)					
PC/HIPS(AB-3)					100
TPP(C)	10			2	10
DPPDP(D)		15		4.7	
BPPE(D)			15		
FLUOROCARBON RESIN(E)	0.3	0.3	0.3	0.3	0.3
PPE(F)					
PHOSPHORUS CONCENTRATION RATIO ( $P_D/P_C$ )				3.6	
THERMAL DEFORMATION TEMPERATURE(°C)	85	104	106	98	79
IZOD IMPACT STRENGTH (kg · cm/cm)	10	2	3	6	7

Table 2 (continued)

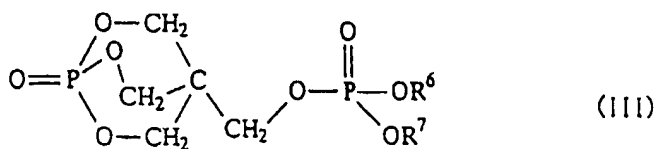
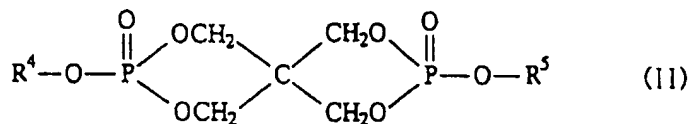
	COMPARATIVE Examples				
	1	2	3	4	5
FLAME RETARDATION (UL94)	B	B	B	B	B

## Claims

1. A polycarbonate-based flame retardant resin composition which comprises an aromatic polycarbonate (A), a styrene-based resin (B), a phosphoric ester compound (C) represented by the following formula (I) and an organic phosphorus compound (D) represented by the following formula (II) or (III), a ratio of a phosphorus concentration of the organic phosphorus compound (D) to that of the phosphoric ester compound (C),  $P_D/P_C$ , being less than 2, which dose not include 0 substantially, in the composition;



wherein  $\text{R}^1$ ,  $\text{R}^2$  and  $\text{R}^3$  are the same as or different from one another and are a phenyl group which may have an alkyl group having 1 to 4 carbon atoms,



wherein  $\text{R}^4$  and  $\text{R}^5$  are aryl groups which may have 1 to 3 alkyl groups having 1 to 4 carbon atoms,  $\text{R}^4$  and  $\text{R}^5$  may be the same as or different from one another,  $\text{R}^6$  and  $\text{R}^7$  each represents a straight chain or branched alkyl group having 1 to 10 carbon atoms, a phenyl group, or an alkyl phenyl group which has 1 to 3 alkyl groups having 1 to 5 carbon atoms.

- The composition according to claim 1, wherein the aromatic polycarbonate (A) is a bisphenol A type aromatic polycarbonate.
- The composition according to claim 1, further comprising a fluorocarbon resin (E).
- The composition according to claim 1, further comprising a polyphenylene ester-based resin (F).
- The composition according to claim 1, which contains 5 to 50 parts by weight of the phosphoric ester compound (C) and 0.5 to 30 parts by weight of the organic phosphorus compound (D) per 100 parts by weight of a thermoplastic resin mixture of 40 to 95 % by weight of the aromatic polycarbonate (A) and 60 to 5 % by weight of the styrene-based resin (B).

6. The composition according to claim 3, which contains 5 to 50 parts by weight of the phosphoric ester compound (C), 0.5 to 30 parts by weight of the organic phosphorus compound (D) and 0.05 to 5 parts by weight of the fluorocarbon resin (E) per 100 parts by weight of a thermoplastic resin mixture of 40 to 95 % by weight of the aromatic polycarbonate (A) and 60 to 5 % by weight of the styrene-based resin (B).
- 5
7. The composition according to claim 4, which contains 5 to 50 parts by weight of the phosphoric ester compound (C), 0.5 to 30 parts by weight of the organic phosphorus compound (D) and 0.1 to 20 parts by weight of the polyphenylene ether (F) per 100 parts by weight of a thermoplastic resin mixture of 40 to 95 % by weight of the aromatic polycarbonate (A) and 60 to 5 % by weight of the styrene-based resin (B).
- 10
8. The composition according to claim 1, which comprises 5 to 50 parts by weight of the phosphoric ester compound (C) and 0.5 to 30 parts by weight of the organic phosphorus compound (D) and further 0.05 to 5 parts by weight of a fluorocarbon resin (E) and 0.1 to 20 parts by weight of a polyphenylene ether (F) per 100 parts by weight of a thermoplastic resin mixture of 40 to 95 % by weight of the aromatic polycarbonate (A) and 60 to 5 % by weight of the styrene-based resin (B).
- 15

20

25

30

35

40

45

50

55



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 99 10 4887

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 098, no. 003, 27 February 1998 & JP 09 286910 A (TEIJIN CHEM LTD), 4 November 1997 * abstract *	1,5	C08K5/521 C08K5/527 C08L69/00
Y	WO 97 41173 A (AKZO NOBEL N.V.) 6 November 1997 * page 8, line 5 - line 9; claims 1,10 *	1,5	
A	US 4 178 281 A (W.E.HORN, JR.) 11 December 1979 * column 2, line 12 - line 34; claims 1,3,5,13 * * column 4, line 45 - line 47 *	1,2,5	
A	US 4 584 331 A (Y.TAMURA ET AL.) 22 April 1986 * column 3, line 22 - column 5, line 42; claims 1,2; table 4 *	1,4	
			TECHNICAL FIELDS SEARCHED (Int.CI.6)
			C08K C08L
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
BERLIN		22 June 1999	Angiolini, D
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 99 10 4887

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

22-06-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9741173 A	06-11-1997	NONE	
US 4178281 A	11-12-1979	CA 1118543 A	16-02-1982
		DE 2921325 A	13-12-1979
		FR 2427360 A	28-12-1979
		GB 2023622 A,B	03-01-1980
		JP 54157156 A	11-12-1979
US 4584331 A	22-04-1986	JP 1669332 C	12-06-1992
		JP 3014072 B	25-02-1991
		JP 59138260 A	08-08-1984
		EP 0116200 A	22-08-1984